

To solve the problem of determining whether a given integer n is a power of two, we can use a mathematical approach that leverages the properties of binary numbers. Here's the solution:

Key Insight:

A power of two in binary representation has exactly one bit set to 1. For example:

- 1 is 1 in binary.
- 2 is 10 in binary.
- 4 is 100 in binary.
- 8 is 1000 in binary, and so on.

Additionally, if n is a power of two, then $n \& (n - 1)$ will be 0. This is because subtracting 1 from n flips all the bits after the single 1 bit (including the 1 bit itself), so the bitwise AND operation results in 0.

Steps:

1. Check if n is greater than 0 (since powers of two are positive).
 2. Use the bitwise operation $n \& (n - 1)$ to check if n has exactly one bit set to 1.
-

Explanation:

1. **Check if $n > 0$:** Powers of two are always positive, so we first ensure n is greater than 0.
 2. **Check $(n \& (n - 1)) == 0$:** This ensures that n has exactly one bit set to 1 in its binary representation.
-

Examples:

1. **Input:** $n = 1$
 - $1 > 0$ is True.
 - $1 \& (1 - 1) = 1 \& 0 = 0$.
 - Output: True.
2. **Input:** $n = 16$
 - $16 > 0$ is True.
 - $16 \& (16 - 1) = 16 \& 15 = 0$.
 - Output: True.
3. **Input:** $n = 3$
 - $3 > 0$ is True.
 - $3 \& (3 - 1) = 3 \& 2 = 2$ (which is not 0).
 - Output: False.

Constraints:

- The solution works within the given constraints: $-2^{31} \leq n \leq 2^{31} - 1$.
-

Why This Works:

- For any power of two, say $n = 2^x$, the binary representation has a single 1 followed by x zeros.
 - Subtracting 1 from n flips all the bits after the single 1 bit, so $n \& (n - 1)$ becomes 0.
 - If n is not a power of two, it will have more than one 1 in its binary representation, so $n \& (n - 1)$ will not be 0.
-

Time Complexity:

- **O(1):** The solution involves constant-time operations (comparisons and bitwise operations).
-

Space Complexity:

- **O(1):** No additional space is used.
-

This approach is efficient and avoids the use of loops or recursion, making it suitable for large values of n .